WHAT IS CLAIMED IS:

1. A method for a medical examination comprising:

polar phase encoding to generate a plurality of signals forming datasets representative of an object, wherein the datasets form a grid in polar coordinates in a k-space.

2. A method in accordance with Claim 1 wherein said phase encoding comprises phase encoding on to the grid of polar coordinates in the k-space to generate magnetic resonance signals representative of the object.

3. A method in accordance with Claim 1 wherein said phase encoding comprises phase encoding on to one of an elliptical grid and a circular grid of polar coordinates in the k-space to generate magnetic resonance (MR) signals representative of the object.

4. A method in accordance with Claim 1 wherein said phase encoding comprises phase encoding on to at least one plane encompassing a finite region in the k-space, each plane passing through a k_z axis of the k-space.

5. A method in accordance with Claim 1 wherein said phase encoding comprises phase encoding on to at least one of:

planes in the k-space;

groups of planes in the k-space;

a first set of regions formed by intersection of the planes with cylinders in the k-space;

a second set of regions formed by intersection of groups of planes with the cylinders;

a third set of regions formed by intersection of the planes with the groups of planes, the first set of regions, and the second set of regions; and

a fourth set of regions formed by union of the planes with the groups of planes, the first set of regions, and the second set of regions, wherein each of the planes and each plane in the groups of planes encompassing a finite region in the k-

space, each of the planes being parallel to each other, each plane in each group being parallel to any other plane in the group, and each group being at an angle to any other group.

6. A method in accordance with Claim 1 wherein said phase encoding comprises phase encoding on to a plane in the k-space.

7. A method in accordance with Claim 6 further comprising constructing a 2-dimensional (2D) image by:

performing a 2D inverse Fourier transformation of the datasets.

8. A method in accordance with Claim 6 further comprising constructing a 2-dimensional (2D) image by:

re-gridding datasets located on the plane on to a grid of cartesian coordinates; and

performing a 2-dimensional backprojection of datasets located on the plane.

9. A method in accordance with Claim 1 wherein said phase encoding comprises phase encoding on to a series of groups of planes in the k-space, wherein each group is at an angle relative to any other group in the series.

10 A method in accordance with Claim 9 further comprising constructing a 3-dimensional (3D) image by:

performing an inverse Fourier transformation, in k_z direction, of datasets located on each group in the series; and

performing a 2-dimensional (2D) inverse Fourier transformation, in k_x and k_y directions, of datasets located on each group in the series.

11. A method in accordance with Claim 9 further comprising constructing a 3-dimensional (3D) image by:

performing an inverse Fourier transformation, in k_z direction, of datasets located on each group in the series; and

performing a 2-dimensional backprojection, along k_x and k_y directions, of datasets located on each group in the series.

12. A method in accordance with Claim 9 further comprising obtaining a high temporal resolution by performing a 2-dimensional inverse Fourier transformation of datasets located on a plane of a group in the series.

13. A method in accordance with Claim 9 further comprising obtaining a high temporal resolution by:

re-gridding datasets located on a plane of a group in the series, wherein the re-gridding is performed on a grid of polar coordinates.; and

performing a 2-dimensional backprojection of datasets located on the plane of the group.

14. A method in accordance with Claim 9 further comprising obtaining a low temporal resolution by:

performing an inverse Fourier transformation in k_z direction of datasets located on each groups in the series;

re-gridding datasets located on each group in the series, wherein the re-gridding is performed along k_x and k_y directions; and

performing a 2-dimensional inverse Fourier transformation in k_x and k_y directions of datasets located each group in the series.

15. A method in accordance with Claim 9 further comprising obtaining a low temporal resolution by:

performing an inverse Fourier transformation in k_z direction of datasets located on each group in the series; and

performing backprojection in k_x and k_y directions of datasets located on each group in the series.

16. A method in accordance with Claim 9 further comprising obtaining a medium temporal resolution by:

performing a 3-dimensional inverse Fourier transformation of datasets located on a group in the series;

performing a maximum intensity projection of datasets located on the group in the series.

17. A method in accordance with Claim 9 further comprising obtaining a medium temporal resolution by performing a 3-dimensional backprojection of datasets located on a group in the series.

18. A method in accordance with Claim 17 further comprising performing a maximum intensity projection of datasets located on the group.

19. A method in accordance with Claim 9 further comprising:

constructing a 3-dimensional (3D) image from datasets located each group in the series; and

updating the 3D image by:

phase encoding on to a first group in the series;

constructing a 3D image from datasets located on each group in the series after phase encoding on to the first group;

phase encoding on to a second group in the series;

constructing a 3D image from datasets located on each group in the series after phase encoding on to the second group;

phase encoding on to a third group in the series; and

constructing a 3D image from datasets located on each group in the series after phase encoding on to the third group.

20. A method in accordance with Claim 1 wherein said phase encoding comprises phase encoding on to a group of planes in the k-space, each plane in the group being parallel to any other plane in the group.

21. A method in accordance with Claim 1 wherein said phase encoding includes phase encoding in which each datum is represented as

$m(a\cos(2\pi d/n)k_x + b\sin(2\pi d/n)k_y + ick_z$, a, b, c, and d are real numbers, m, n, and i are an integers, and k_x, k_y, and k_z being unit basis vectors in the k-space.

22. A method in accordance with Claim 21 further comprising forming a nested loop, the nested loop comprising:

frequency encoding n_1 times along a k_z axis by keeping m, a, d, b, n, and c constant, and varying i,

phase encoding radially once by keeping a, d, b, n, and c constant and varying m for every n_1 number of times of frequency encoding;

phase encoding radially for n_2 number of times;

phase encoding rotationally once by keeping a, b, n, and c constant and varying d for every n_2 number of times of radial phase encoding; and

phase encoding rotationally for n_3 number of times.

23. A method in accordance with Claim 1 wherein said phase encoding includes phase encoding in which each datum is represented as $m(a\cos(2\pi d/n)k_x + b\sin(2\pi d/n)k_y) + jr(a\cos(2\pi d/n)k_x + b\sin(2\pi d/n)k_y) + ick_z$, a, b, c, d, and r are real numbers, m, j, n, and i are an integers, and k_x, k_y, and k_z being unit vectors in the k-space.

24. A method in accordance with Claim 23 further comprising forming a nested loop, the nested loop comprising:

frequency encoding the datasets m_1 times along a k_z axis by keeping m, a, d, n, b, j, r, and c constant, and varying i;

phase encoding radially once by keeping a, d, n, b, j, r, and c constant and varying m for every n_1 number of times of frequency encoding;

phase encoding radially for m_2 number of times;

phase encoding translationally once by keeping a, d, n, b, r, and c constant and varying j for every m_2 number of times of radial phase encoding;

phase encoding translationally for m_3 number of times;

phase encoding rotationally once by keeping a, n, b, r, and c constant and varying d for every m_3 number of times of translational phase encoding; and

phase encoding rotationally for m_4 number of times.

25. A magnetic resonance (MR) method for medical examinations comprising:

injecting a patient with a contrast agent that flows into a vasculature of the patient;

acquiring MR signals produced by spins in the vasculature from an MR imaging system; and

polar phase encoding to generate the MR signals forming datasets representative of the patient, wherein the datasets form a grid in polar coordinates in a k-space.

26. A method for a medical examination comprising:

sampling datasets on to a grid of polar coordinates in a k-space to generate signals representative of an object of interest that is being medically examined.

27. A method in accordance with Claim 26 wherein said sampling comprises sampling by one of phase encoding, Echo-planar Imaging (EPI), and spiral imaging of the signals of the object.

28. A magnetic resonance imaging (MRI) system comprising:

a main magnet to generate a uniform magnetic field;

a radio frequency pulse generator for exciting the magnetic field;

a gradient field generator for generating gradients extending in different directions in the magnetic field;

a receiver for receiving magnetic field magnetic resonance (MR) signals representative of an object; and

a controller for polar phase encoding to generate the MR signals forming datasets representative of the object, wherein the datasets form a grid in polar coordinates in a k-space.

29. A controller programmed to:

polar phase encode to generate a plurality of magnetic resonance (MR) signals forming datasets representative of an object, wherein the datasets form a grid in polar coordinates in a k-space.